

# Distributed, Passivity-Based, Aeroservoelastic Control (DPASC) of Structurally Efficient Aircraft in the Presence of Gusts Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



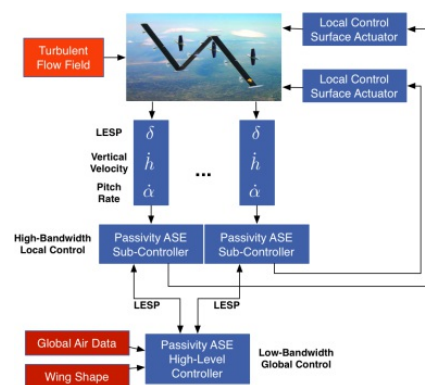
## ABSTRACT

Control of extremely lightweight, long endurance aircraft poses a challenging aeroservoelastic (ASE) problem due to significantly increased flexibility, and aerodynamic, structural, and actuator nonlinearities. To obtain the benefits of increased aerostructural efficiency, the controller needs to trim at a specified optimal shape while minimizing structural fatigue from gust disturbances. Tao Systems, Texas A&M University and University of Minnesota propose to develop a distributed, passivity-based, ASE controller (DPASC) using sectional aerodynamic and structural output-only feedback. This scalable approach has the potential to minimize the impact of aerodynamic / structural uncertainties and control surface free-play / saturation, while guaranteeing global asymptotic stability.

## ANTICIPATED BENEFITS

### To NASA funded missions:

Potential NASA Commercial Applications: The benefits of a distributed, passivity-based ASE system that we are proposing has a number of benefits: (1) addresses nonlinearities in aerodynamics, structures, and actuation, (2) increases controller robustness: reduces dependency on aerodynamic and structural uncertainties, (3) increases aerostructural efficiency, (4) enables mission persistence at a lower cost. For example, degradation due to atmospheric effects such as moisture and fatigue caused by constant wing stresses provides significant risk over the life of a HALE-type UAV, e.g., DARPA Vulture. Longevity of components is also a major technological risk. Using extremely high aspect ratios reduces drag. The system can utilize dynamic soaring for further aerodynamic efficiency. The system can be adapted for using optimal control for efficient path planning or gaining aerodynamic advantages through formation flight.

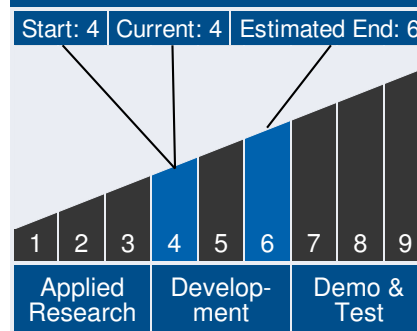


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## Technology Maturity



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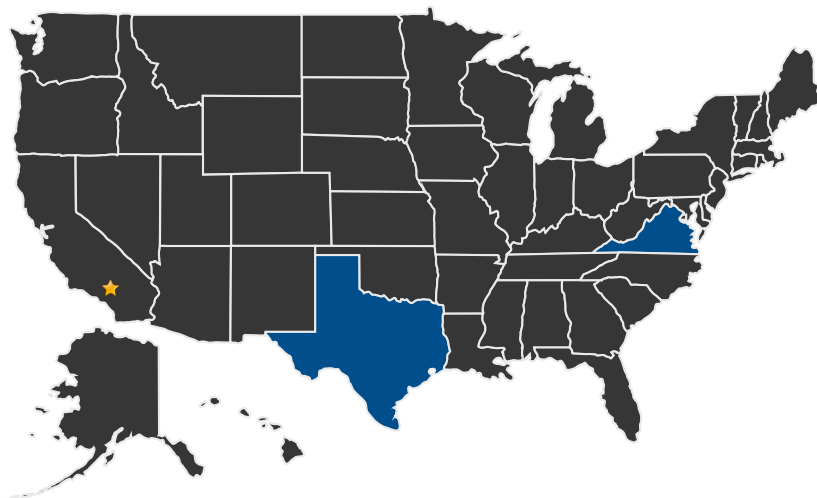
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## To the commercial space industry:

Potential Non-NASA Commercial Applications: The ability to cruise efficiently at a range of altitude, enabled by a substantial increase in cruise lift-to-drag (L/D) ratios over today's high-altitude aircraft, provides sustained presence and long range. Aerodynamic load/moment sensors would enable the efficient, robust active control of adaptive, lightweight wings to optimize lift distribution to maximize L/D. Cost-effectively improving the energy capture and reliability of wind turbines would help national renewable energy initiatives. A standalone aerodynamic load/moment sensor could provide output for control feedback to mitigate the turbine blade lifetime-limiting time varying loads generated by the ambient wind.

## U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States  
With Work

★ **Lead Center:**  
Armstrong Flight Research Center

## Management Team

### Program Executive:

- Joseph Grant

### Principal Investigator:

- Arun Mangalam

## Technology Areas

### Primary Technology Area:

Optimize Air/Ground Functional Allocations (TA 15.1.2.3)

### Secondary Technology Area:

Robotics and Autonomous Systems (TA 4)

└ System-Level Autonomy (TA 4.5)

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## Other Organizations Performing Work:

- Tao of Systems Integration, Inc. (Hampton, VA)
- The Texas A&M Engineering Experiment Station (College Station, TX)

## PROJECT LIBRARY

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### Presentations

- Briefing Chart
  - (<http://techport.nasa.gov:80/file/17922>)

## DETAILS FOR TECHNOLOGY 1

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### Technology Title

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